Claims Listing:

1. (original) A photonic device, comprising:

a silicon semiconductor based superlattice that includes a plurality of layers that form a plurality of repeating units, wherein at least one of the layers in the repeating unit is an optically active layer with at least one species of rare earth ion and at least two units in a repeating unit have different thicknesses.

2. (original) The device of claim 1, wherein each layer in the plurality of layers is a pure crystalline structure.

3. (original) The device of claim 1, wherein the rare earth ion is present with a density of at least 10^{18} ions per cubic cm.

4. (original) The device of claim 1, further comprising:

one or more cladding layers coupled to the superlattice configured to guide and propagate an optical mode that overlaps at least a portion of the superlattice.

5. (original) The device of claim 1, further comprising:

first and second electrodes , wherein at least a portion of the superlattice is positioned between the first and second electrodes.

6. (original) The device of claim 1, further comprising:

a least one electrode that extends from an exterior of the superlattice to an interior of the superlattice.

7. (original) The device of claim 1, further comprising:

at least one electrically doped p- or n-type layer coupled to the superlattice.

8. (original) The device of claim 1, wherein the optically active layer is sandwiched between doped p- or n-type layers.

9. (original) The device of claim 1, further comprising:

a mode size converter configured to be coupled to an optical fiber and the superlattice.

10. (original) The device of claim 1, wherein the mode size converter is a tapered waveguide structure.

11. (original) The device of claim 1, wherein the repeating units are periodic.

12. (original) The device of claim 1, wherein the repeating units have uniform layer constructions.

13. (original) The device of claim 1, wherein the superlattice structure is selected to create a global crystal field that interacts with the local crystal field of the constituent host layers to produce a pre-determined optical spectrum of the structure.

14. (original) The device of claim 1, wherein a crystal field of the device is configured to be spatially variable by altering composition of layers.

15. (original) The device of claim 1, wherein a composition of the repeating units varies as a function of distance along a superlattice growth.

16. (original) The device of claim 1, wherein at least one of the layers is amorphous.

17. (original) The device of claim 1, wherein at least a portion of the active region layer is a narrow band gap semiconductor relative to other layers in a repeating unit.

18. (original) The device of claim 1, wherein at least a portion of the active region layer is a wide band gap semiconductor relative to other layers in a repeating unit.

19. (original) The device of claim 1, further comprising at least one spacer layer between two adjacent repeating units.

20. (original) The device of claim 19, wherein the spacer layer varies in thickness along a growth direction.

21. (original) The device of claim 1, wherein the repeating units includes ultra-thin layers.

22. (currently amended) The device of claim ~~133~~ 21, wherein the ultra-thin layers have a thickness of 1000 Å or less.

23. (currently amended) The device of claim ~~133~~ 21, wherein the ultra- layers are thin enough to be non-bulk material layers.

24. (original) The device of claim 1, wherein each repeating unit has two or more layers.

25. (original) The device of claim 1, wherein each repeating unit is repeated N times,

where N is a whole or partial integer of monolayers.

26. (original) The device of claim 1, wherein each repeating unit has at least two layers made with different compositions.

27. (original) The device of claim 1, wherein each repeating unit has at least two layers with different thicknesses.

28. (original) The device of claim 1, wherein each repeating unit has three layers made of with different compositions.

29. (original) The device of claim 1, wherein each repeating unit has a silicon oxide layer.

30. (original) The device of claim 1, wherein each repeating unit has an oxygen-doped silicon layer.

31. (original) The device of claim 1, wherein each repeating unit includes an electrically doped p- or n-type layer.

32. (original) The device of claim 1, further comprising:

at least one crystal growth modifier M included in at least one crystalline layer of each repeating unit in the form of SiMx, where x is less than 1.

33. (original) The device of claim 32, wherein the growth modifier M is a crystalline compound comprising a rare-earth R and M is at least one of C, H, O, N, P, As, B, Sb, Co, Ni, Ir, Sn and Pb in the form RxMy.

34. (original) The device of claim 1, wherein the rare earth ion is selected from at least one of Er, Pr, Nd, Eu, Ho, Pm, Tb, Sm, Tm and Yb.

35. (original) The device of claim 1, wherein the rare earth ion is Er.

36. (original) The device of claim 1, wherein the multi-layer silicon based superlattice is positioned on a silicon substrate.

37. (original) The device of claim 1, wherein the multi-layer silicon based superlattice is grown on a silicon substrate.

38. (original) The device of claim 1, wherein the multi-layer silicon based superlattice is

grown on an (001)-oriented surface of the silicon substrate.

39. (original) The device of claim 1, wherein the multi-layer silicon based superlattice is grown on a (111)-oriented surface of the silicon substrate.

40. (original) The device of claim 1, wherein the multi-layer silicon based superlattice is grown on at least one h, k and l-oriented surface of the silicon substratem wherein h, k, and l are sets of integers that are crystallographic Miller indices notation.

41. (original) The device of claim 1, wherein the multi-layer silicon based superlattice is grown on one of a geometrically and compositionally patterned silicon substrate.

42. (original) The device of claim 1, wherein the multi-layer silicon based superlattice is deposited in a superlattice growth direction and has a laterally ordered structure substantially perpendicular to a growth direction.

43. (original) The device of claim 1, wherein the multi-layer silicon based superlattice is deposited in a superlattice growth direction and has a laterally ordered structure substantially perpendicular to a growth direction.

44. (original) The device of claim 1, wherein the multi-layer silicon based superlattice is grown on a silicon-on-insulator wafer.

45. (original) The device of claim 1, wherein the active region layer has a lattice constant that is less than a lattice constant of an underlying bulk silicon substrate.

46. (original) The device of claim 1, wherein the active region layer has a lattice constant that is less than a lattice constant of a on a pseudo-substrate buffer layer with a lattice constant that is different from a lattice constant of an underlying bulk silicon substrate.

47. (original) The device of claim 1, wherein the active region layer has a lattice constant that is equal to a lattice constant of an underlying bulk silicon substrate.

48. (original) The device of claim 1, wherein the active region layer has a lattice constant that is equal to a lattice constant of a on a pseudo-substrate buffer layer with a lattice constant that is different from a lattice constant of an underlying bulk silicon substrate.

49. (original) The device of claim 1, wherein the active region layer has a lattice constant that is greater than a lattice constant of an underlying bulk silicon substrate.

50. (original) The device of claim 1, wherein the active region layer has a lattice constant that is greater than a lattice constant of a on a pseudo-substrate buffer layer with a lattice constant that is different from a lattice constant of an underlying bulk silicon substrate.

51. (original) The device of claim 37, wherein at least one layer in a repeating unit has a lattice constant that is sufficiently different from a lattice constant of the substrate to be substantially in a state of elastic mechanical stress.

52. (original) The device of claim 37, wherein at least two of layers of repeating units have substantially equal and opposite mechanical strain energy and strain states and each repeating unit is substantially lattice matched to the silicon substrate.

53. (original) The device of claim 37, wherein at least two of layers of repeating units have substantially equal and opposite mechanical energy and strain states and each repeating unit is substantially lattice matched to the pseudo-substrate buffer layer.

54. (original) The device of claim 14, wherein the crystal field is modified by a strain field induced by lattice mismatched layers in a repeating unit.

55. (original) A photonic device, comprising:

a silicon semiconductor based superlattice that includes a plurality of layers that form a plurality of repeating units, wherein at least one of the layers in the repeating unit is an optically active layer with at least one species of rare earth ion and at least two units in a repeating unit are made of different compositions.

56. (original) The device of claim 55, wherein each layer in the plurality of layers is a pure crystalline structure.

57. (original) The device of claim 55, wherein the rare earth ion is present with a density of at least 10^{18} ions per cubic cm.

58. (original) The device of claim 55, further comprising:

one or more cladding layers coupled to the superlattice configured to guide and propagate an optical mode that overlaps at least a portion of the superlattice.

59. (original) The device of claim 55, further comprising:

first and second electrodes , wherein at least a portion of the superlattice is positioned between the first and second electrodes.

60. (original) The device of claim 55, further comprising:

a least one electrode that extends from an exterior of the superlattice to an interior of the superlattice.

61. (original) The device of claim 55, further comprising:

at least one electrically doped p- or n-type layer coupled to the superlattice.

62. (original) The device of claim 55, wherein the optically active layer is sandwiched between doped p- or n-type layers.

63. (original) The device of claim 55, further comprising:

a mode size converter configured to be coupled to an optical fiber and the superlattice.

64. (original) The device of claim 55, wherein the mode size converter is a tapered waveguide structure.

65. (original) The device of claim 55, wherein the repeating units are periodic.

66. (original) The device of claim 55, wherein the repeating units have uniform layer constructions.

67. (original) The device of claim 55, wherein the superlattice structure is selected to create a global crystal field that interacts with the local crystal field of the constituent host layers to produce a pre-determined optical spectrum of the structure.

68. (original) The device of claim 55, wherein a crystal field of the device is configured to be spatially variable by altering composition of layers.

69. (original) The device of claim 55, wherein a composition of the repeating units varies as a function of distance along a superlattice growth.

70. (original) The device of claim 55, wherein at least one of the layers is amorphous.

71. (original) The device of claim 55, wherein at least a portion of the active region layer is a narrow band gap semiconductor relative to other layers in a repeating unit.

72. (original) The device of claim 55, wherein at least a portion of the active region layer is a wide band gap semiconductor relative to other layers in a repeating unit.

73. (original) The device of claim 55, further comprising at least one spacer layer between two adjacent repeating units.

74. (original) The device of claim 73, wherein the spacer layer varies in thickness along a growth direction.

75. (original) The device of claim 55, wherein the repeating units includes ultra-thin layers.

76. (original) The device of claim 75, wherein the ultra-thin layers have a thickness of 1000 Å or less.

77. (original) The device of claim 75, wherein the ultra- layers are thin enough to be non-bulk material layers.

78. (original) The device of claim 55, wherein each repeating unit has two or more layers.

79. (original) The device of claim 55, wherein each repeating unit is repeated N times, where N is a whole or partial integer of monolayers.

80. (original) The device of claim 55, wherein each repeating unit has at least two layers made with different compositions.

81. (original) The device of claim 55, wherein each repeating unit has at least two layers with different thicknesses.

82. (original) The device of claim 55, wherein each repeating unit has three layers made of with different compositions.

83. (original) The device of claim 55, wherein each repeating unit has a silicon oxide layer.

84. (original) The device of claim 55, wherein each repeating unit has an oxygen-doped silicon layer.

85. (original) The device of claim 55, wherein each repeating unit includes an electrically doped p- or n-type layer.

86. (original) The device of claim 55, further comprising:

at least one crystal growth modifier M included in at least one crystalline layer of each repeating unit in the form of SiM_x, where x is less than 1.

87. (original) The device of claim 85, wherein the growth modifier M is a crystalline compound comprising a rare-earth R and M is at least one of C, H, O, N, P, As, B, Sb, Co, Ni, Ir, Sn and Pb in the form RxMy.

88. (original) The device of claim 55, wherein the rare earth ion is selected from at least one of Er, Pr, Nd, Eu, Ho, Pm, Tb, Sm, Tm and Yb.

89. (original) The device of claim 55, wherein the rare earth ion is Er.

90. (original) The device of claim 55, wherein the multi-layer silicon based superlattice is positioned on a silicon substrate.

91. (original) The device of claim 55, wherein the multi-layer silicon based superlattice is grown on a silicon substrate.

92. (original) The device of claim 55, wherein the multi-layer silicon based superlattice is grown on an (001)-oriented surface of the silicon substrate.

93. (original) The device of claim 55, wherein the multi-layer silicon based superlattice is grown on a (111)-oriented surface of the silicon substrate.

94. (original) The device of claim 55, wherein the multi-layer silicon based superlattice is grown on at least one h, k and l-oriented surface of the silicon substratem wherein h, k, and l are sets of integers that are crystallographic Miller indices notation.

95. (original) The device of claim 55, wherein the multi-layer silicon based superlattice is grown on one of a geometrically and compositionally patterned silicon substrate.

96. (original) The device of claim 55, wherein the multi-layer silicon based superlattice is deposited in a superlattice growth direction and has a laterally ordered structure substantially perpendicular to a growth direction.

97. (original) The device of claim 55, wherein the multi-layer silicon based superlattice is deposited in a superlattice growth direction and has a laterally ordered structure substantially perpendicular to a growth direction.

98. (original) The device of claim 55, wherein the multi-layer silicon based superlattice is grown on a silicon-on-insulator wafer.

99. (original) The device of claim 55, wherein the active region layer has a lattice constant that is less than a lattice constant of an underlying bulk silicon substrate.

100. (original) The device of claim 55, wherein the active region layer has a lattice constant that is less than a lattice constant of a on a pseudo-substrate buffer layer with a lattice constant that is different from a lattice constant of an underlying bulk silicon substrate.

101. (original) The device of claim 55, wherein the active region layer has a lattice constant that is equal to a lattice constant of an underlying bulk silicon substrate.

102. (original) The device of claim 55, wherein the active region layer has a lattice constant that is equal to a lattice constant of a on a pseudo-substrate buffer layer with a lattice constant that is different from a lattice constant of an underlying bulk silicon substrate.

103. (original) The device of claim 55, wherein the active region layer has a lattice constant that is greater than a lattice constant of an underlying bulk silicon substrate.

104. (original) The device of claim 55, wherein the active region layer has a lattice constant that is greater than a lattice constant of a on a pseudo-substrate buffer layer with a lattice constant that is different from a lattice constant of an underlying bulk silicon substrate.

105. (original) The device of claim 91, wherein at least one layer in a repeating unit has a lattice constant that is sufficiently different from a lattice constant of the substrate to be substantially in a state of elastic mechanical stress.

106. (original) The device of claim 91, wherein at least two of layers of repeating units have substantially equal and opposite mechanical strain energy and strain states and each repeating unit is substantially lattice matched to the silicon substrate.

107. (original) The device of claim 91, wherein at least two of layers of repeating units have substantially equal and opposite mechanical energy and strain states and each repeating unit is substantially lattice matched to the pseudo-substrate buffer layer.

108. (original) The device of claim 91, wherein the crystal field is modified by a strain field induced by lattice mismatched layers in a repeating unit.